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ABSTRACT

The concept of computer literacy is examined as it applies to two-year colleges. The paper begins with definitions of the term, emphasizing the skills, knowledge, and attitudes toward computers that are considered criteria for computer literacy. The paper continues by describing a conference at which educators attempted to visualize the technology of the future and its implications and by listing areas in which these educators were successful (e.g., predicting the intelligent videodisc) and unsuccessful. Next, six reasons why a broad base of computer literacy is needed are examined, including reasons related to the changing economy, the changing nature of jobs, promotion of equity in access to computers, world competition, the need to encourage student skills, and the need to understand issues of public policy for technology. The paper then suggests priorities for planning computer literacy programs, which include, in order of importance, enhancing the computer literacy of educational administrators, planning curricula for the use of the computer, purchasing hardware and software to support the curricula, supporting faculty members who encourage computer literacy, supporting academic computing facilities, gaining assistance from industry, and fostering computer literacy at pre-college levels. The paper concludes with a projected profile of the computer-literacy level of the entering college class of 1985, which foresees a wide variation in experience with computers. (KL)

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COMPUTER LITERACY

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COMPUTER LITERACY

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I. Computer as Rorschach

I have been concerned for the past fifteen years, with the needs of people for computer-related skills and knowledge. The phrase "computer literacy" has come to be used to denote these needs. I have concluded that computer literacy is not an academic discipline, not a body of knowledge to be acquired.

Computer literacy is more like a Rorschach test than a discipline. Computer literacy is a phrase onto which we each project our values, our experiences, our skills, our visions of the future as it pertains to technology, to computers, to communications, to information.

Each of us here today is influencing the definition and meaning of computer literacy for ourselves and for our students for many years to come. This is because of our special place in history, in which change is taking place very rapidly. It is only in the past very few years that computers became available and accessible to nearly everyone Each of us in this room can afford to buy one, and most of our students can, too.

So, I want to begin this session with the notion that we have both the opportunity and the responsibility to take charge of computer literacy, to define and operationalize it in ways that will benefit ourselves, our students and our society.

There are no experts to turn to in defining computer literacy.

II. Overview

I will describe; 1) definitions of computer literacy; 2) importance of visualizing the future; 3) why computer literacy is needed; 4) priorities for planning; 5) level of computer literacy to expect in the entering students.

III. Definitions

There are about as many definitions of computer literacy as there are people starting them. One that I think is useful is the following+:

"Computer literacy is whatever a person needs to be able to know about and do with computers in order to function effectively in our information-based society." This definition points out that what skills and knowledges and attitudes are needed will vary from person to person and from time to time, depending on what it is they are doing. This definition also points out that computers are tools in service of other work -- not an end in themselves.

In our work with computer literacy for children in grades kindergarten through eight we have adopted this definition: "The ability to use suitably programmed computers in appropriate ways to accomplish tasks and solve problems; and the ability to make informed judgements about social and ethical issues involving computer and communications systems.

My point about definitions of computer literacy, is that the skills, knowledge and attitudes your students need to have with regard to computers, can only be derived from your analysis of what a person in your profession or industry or society needs to be able to do with computers in order to function effectively in that career, in subsequent careers, and as a citizen. There is no point in waiting for some curriculum committee from the Association for Computing Machinery to figure it out, because that's not their mission. And if you depend on your own computer science department to figure it out for you, you will wait a long time because there are hundreds of disciplines and the computer science department would have to have a staff of about a hundred just to do the task analysis.

General categories of skills, knowledge and attitudes that different people include under the phrase "computer literacy" include:

*Feeling comfortable and in control when using computer systems. This is called "Computer Comfort"

*Using computer programs and data bases and communications

*Developing procedural or algorithmic solutions to problems. This is in my opinion the most fundamental and important component of computer literacy. The procedure or algorithm one develops may be or may not be implemented in the form of a computer program

*Analyzing social issues that relate to computers, communications, and their social impacts

*Some people say that ability to write computer programs is a critical component of computer literacy. While this is obviously needed by some people, I am not convinced its a universal requirement

IV. Visualizing the Future

In planning for computer literacy, the most important thing is to project our image of the future. I will illustrate this point with a story.

In 1975, the National Science Foundation sponsored an invited conference with the title "Computer Technology in Education in 1985". The conference assembled the most knowledgeable persons from the forefront of reasearch and development in computers and communications technology, who described major developments expected over the next ten years. Educators were than to envision the implications of these technologies for edu-

cation in the year 1985. The technologists and educators were then to recommend to the Federal Government, policies, projects and programs that would be responsive to and take advantage of the new technologies. At this conference, we learned first-hand about large scale integration and its projected impact on systems architecture and costs. We learned about developments in bubble memory and other storage and their implications for computer systems performance and cost. Similarly, we shared in the excitement over intelligent videodisk, advances in artificial intelligence, communications facilities, and the man-machine interface. We were informed for example, that by 1980 the costs for storing and transmitting information electronically would be less than that for print technology. Between 1980 and 1985, they said, there would be a hundredfold increase in use of computers for information storage and retrieval compared to 1975.

This conference succeeded, I think, in identifying the major technological developments that have come about between 1975 and the present. The potential of intelligent videodisks, for example, was clearly identified, and the government did in fact initiate support for several major research and development projects in that area as a result of the conference.

In a larger and more important sense, however, I think that the educators and technologists at that conference really missed the boat. Despite all our intelligence, the best available information, and really good intentions, we completely failed to zero in on the major educational implications of these technologies. We couldn't really visualize the future we were hearing about, and we couldn't adjust to a more rapid rate of change than we had experienced in the past. We hear the figures, but we couldn't visualize those millions of people who would discover the need to become computer-literate. We couldn't visualize the printer's unions and the projectionists unions, fighting against the chips that were replacing them in their jobs. We couldn't visualize the millions of office workers struggling with their word-processors and electronic mail systems. We couldn't predict the thousands of school teachers grappling with integer BASIC and Applesoft. We didn't see the army of journalists from Time and Newsweek wanting to know what chips and bits are all about.

If the participants in that conference had been able to visualize the future in human terms, the number one recommendation would have focused on the need for computer literacy. It would have called for curriculum reform, for example, and for faculty development, and for research on how to make people computer literate.

V. Why Computer Literacy is Needed

People have different reasons for thinking computer literacy is important, and here again we're projecting our visions and values.

I'll summarize some of the reasons why computer literacy is so important.

1. Changing Economy

Our society is fundamentally and rapidly changing in its structure and activities. These changes are rooted in new ways of generating, storing, communicating and using information. We, our students, and all our citizens must arm ourselves with understanding, skills, knowledge and tools to cope with these changes. We are making a rapid shift from production of material goods to production, distribution and application of knowledge and information. We are losing some of our cheap, accessible energy sources and raw materials.

According to the US Dept. of Commerce, 46 percent of our GNP and over half of our jobs are functions of information activities. The most significant growth in U.S. productivity since WW II is due to production, distribution and application of knowledge. Every industry we have depends now on information and technology to improve productivity. In the auto industry, for example, executives of General Motors and Volkswagen have predicted that computer-aided design and assembly line robots will make obsolete 100% of existing production line jobs within five years. Electronic publishing systems, a product of microelectronics and communications systems, may change drastically many of our traditional print media, libraries, newspapers, and the entire publishing industry. What will electronic yellow pages do to the advertising income of traditional newspapers? What will electronic books do to the publishing industry? Electronic books are significant not only in that they will involve a massive change in industries, but perhaps more significant in their nature. Printed books are passive; electronic books are interactive. A simple example is a dictionary. You type into the chip-reader a word or a phrase describing the problem area and the computer will respond, probably with one or two questions to refine your inquiry, and finally generate a summary of the information you need.

2. Changing Jobs and Professions

New skills are needed, as a result of this shift in the basis of our economy and our productivity. In a paper titled, "The Computerized Destruction of the Western Civilization," R. D. Parslow predicts massive disruptions in work force and unemployment that will make the industrial revolution of the 1800's look like a minor blip in human history in comparison. The most immediate impact will be on office workers. Those office workers who do retain their jobs need new skills. We are replacing typewriters with computer based word processors; file cabinets with magnetic disks; mail with electronic communications networks. The typist or file clerk no longer works with physical objects like paper files, physical layouts of papers, physical mail. The person is working with abstractions like logical files, instructions to the computer about formats, management of disks and files, switched and dedicated lines, asynchronous and bisynchronous communications, compatibility of transmission images from one kind of office machine or computer to another. The person is troubleshooting, diagnosing problem situations, in complex systems with many components none of which have familiar, concrete, mechanical structures.

3. Equity

There is a rapidly increasing gap between the haves and the have nots. Those in our society who know how to access and use information and who know how to use our technology based tools, are the people with the power to control industry, economics and social decision making. Those who don't know how to get and use information, and who don't understand the tools, are increasingly unemployed and alienated. Some observers such as Parslow whom I mentioned earlier, fear we will experience rapid increase in crime and violence as a consequence.

Our public schools are no longer the route to equal opportunity and mobility. The children of professionals and technical people have access to microcomputers, to data bases, to practice in complex problem solving, that the masses do not have. This is because educational institutions have been rapidly left behind in this revolution. Children in school are still memorizing dates instead of learning how to access the right data bases when they need the information. Children in school are still spending several years memorizing basic computational algorithms, instead of learning how to develop procedures and algorithms to solve problems. For the near future, I see very little hope of this situation improving much in the public schools for many reasons mostly the lack of computer literacy on the part of school administrators and teachers. Therefore, the burden for a least the next few years will fall on the community colleges and four year colleges to remediate this gap.

4. World Competition

Some people, especially now in the auto industry, believe the U.S. is in a desperate economic race with other advanced countries for its economic survival. Our ace in the hole competitively has been our leadership in science and high technology. But this is rapidly changing. The British, French, West Germans and Japanese are offering significant threat to the U.S. position of leadership in technology. Commerical firms, educational institutions and governments are joining together to put computers in schools at the earliest grades. Valerie Gestard DEstang proclained a computer literacy week in France, and ordered that 20,000 micros be installed in schools. In England, the Prime Minister set up centers for computer assisted instruction and research on microcomputer applications for education. The Japanese have enunciated a specific policy of moving away from an industrial to an information-based society. In his book the Micro Millenium, Christopher Evans reported the Japanese industrial strategy for the 1980's as described by the vice president of one of Japans largest computer companies. The oil crisis and shifts in balance of power throughout the world meant that Japan would be unable to maintain, let alone increase, its standard of living in the years to come if it relied on such archaic means of making money as selling motor cars, cameras, tape recorders and the like. The solution was obvious. Japan had to make itself the number one computer power in the 1980's. The Japanese Government, in consortium with industrial investors, was injecting about 70 BILLION dollars into the computer industry in the decade 1975-1985. Almost half that budget would be spent on computer training and teaching -- about 3 billion a year.

5. Productivity of Colleges

A fifth reason for the urgency of computer literacy, and it follows from the others, is that colleges need to produce students who can survive in the marketplace. You understand better than I do, that your graduates will have better success in career and education paths if, for example+:

-a graduate from environmental studies or international relations has used and developed computer simulations of the phenomena she studied;

-a graduate from the laboratory science has used laboratory automation devices and systems in his lab;

-a graduate in industrial engineering can design and program industrial robots;

-a graphic artist has used computer graphics and computer aided design tools in school;

-a graduate in print media and newspapers is conversant with electronic storage, communication and retrieval systems.

Students who have learned these skills in using information, in using computers and communications systems, in solving complex problems, will not only have better placement initially as you know, but also will be better able to continue their learning, as the technology changes force them into new specialities and industries.

A national consensus panel chaired by Irving Shain, Chancellor of University of Wisconsin, published last month a statement of national policy issues on computing and higher education. The panel stated that, "Just as today it is assumed that every student has access to a library, so by the end of the 80's every student will be expected to have access to a full range of computing and information services. The mass production of home computers will provide each student with an inexpensive computer terminal by the end of the decade. Universities must respond to these rapid technological changes in order to maintain the relevance and quality of education, to improve productivity, and to take full advantage of the new opportunities."

6. Public Policy Issues Relating to the New Technologies

If we are to resolve these issues in a way that preserves a semblance of democracy, then our citizens have to know what's going on. There are news stories daily about issues, for example, like the role of AT&T in providing information services and what effects this will have on the newspaper and other industries. The resolution of such issues may affect our personal privacy, our protection from crime, our economic well-being, our voice in political processes, our ability to educate ourselves and our children, the cost of services, and a host of other things we can't even yet imagine. And yet even most of the citizens haven't the faintest idea that these issues exist, much less what their implications are. Most citizens do not have any idea how to evaluate the appropriateness of computer systems and applications.

VI. Priorities

Given that there is much work to be done in ensuring that our institutions and students be prepared to survive this revolution, what are the priorities for planning and action? I'd like to suggest a priority list that is based on our studies of computer-literate colleges over the past decade, and based on our current work in national computer-literacy issues and policies.

1. First priority is computer literacy of educational administrators. The understanding and aggressive backing of governing boards and administration for computer literacy and instructional computing is absolutely essential. Administrators need not only to understand the importance and nature of computer roles in managing the institution, but more importantly to understand the importance and nature of computing in learning and teaching. This understanding needs to be made visible, in the form of formal policy statements, budget decisions, and incentives provided for curriculum change and faculty development. For example, a 1975 College Bulletin of a liberal arts college states[+]:

"It is important for every educated individual in todays world to know something about computers and the way they are used to process information and make decisions. Computers directly influence our lives in an increasing variety of ways. The crucial issues involved in society's use of computers are far too important to be left only in the hands of experts."

2. Equally important is curriculum planning. Faculty in each school, department and academic program area must sit down together and, with as much vision as they can muster, try to foresee the kinds of computer- and information-related skills and knowledges their students will need in the next few years. What tools and information will our graduates need to be able to use in our field? What problem-solving skills will they need? What kinds of software will they need to use or develop? What data bases will they need to access?

What are the new requirements for ethics, law and public policy that these new technologies imply? We've always had certain ethics and rules that we pass on to our students as a part of scholarship. Rules against plagiarism, against cheating on tests, ethics about who gets authorship on publications, etc. What are the new rules that we need in order to survive socially with electronic media? Thou shalt not steal thy neighbor's program? Thou shalt not deliberately crash the system? And what about conventions that make our lives more civilized and enable us to communicate with each other? It is ironic that at a time when more collaboration among people is needed than ever before, to solve complex problems and work on large systems, that we are getting a whole generation of computer programs that are undocumented, unstructured, unusable by anyone than the originator. This problem will get worse over the next few years, as we have a whole generation of high school students coming up who are learning the rudiments of coding in general purpose languages like BASIC, but are not learning how to structure their programs, how to document them so that others can understand, operate, modify or interface with them.

So the infusion of computer literacy into the curriculum must take into account not only the skills and knowledges needed by individuals in their work, but also how individuals collaborate and interact.

Having an idea of how their discipline is changing and the requirements for skills and knowledge in their field, faculty then can address the ways in which these new requirements will be met by the curriculum. Are new courses needed? Should courses be modified to incorporate new methods or problems? Can the technology itself be used to help in instruction? For example in the field of film and television, should we be using intelligent videodisk as a medium of instruction as well as an object of learning?

Specifying computer-related prerequisite skills and knowledge is an important part of this process. Student is assumed to be experienced in using SPSS, student knows how to use computer graphics, student able to write structured programs, whatever. For students who don't have the prerequisite skills, we have to provide remedial courses, just as we provide remedial reading, writing, and math courses.

3. Derive requirements for learning materials, hardware, software and communications resources needed to support the curriculum. These must follow from the curriculum needs. There are too many technology options to leave these decisions to purely political or capricious accident. As one trivial example, you would not want to be trying to teach about electronic communications networks through computer-assisted instruction on a stand-alone microcomputer. If students need to know about and be able to use electronic communications, they need to be using those kinds of systems in their studies. You would not have your students learn to use computer-aided design languages by having them take a batch oriented Fortran course.

The key here is appropriate technology. And what is appropriate can only be known through an understanding of the purpose and goals of the curriculum. If biology or environmental studies students need to be able to use, critique, modify or develop simulations, they need lots of examples of simulations to work on; they need appropriate simulation languages and software for development; they need well-documented examples to learn from.

Students will be able to do some of their work on their own stand alone personal computers. But they'll need to connect to campus facilities including communications networks, software libraries, data bases. Establishing standard interfaces and protocols will be a problem. Central or even distributed mainframes will be a bottleneck unless we work out good arrangements for off loading much of the work load onto the personal machines. Allocation of functions to central, local and personal computers will have to be worked out.

4. Provide support for the faculty. If faculty are to make the changes needed in their courses and in their own skills, they need support of various kinds. First comes time. Release time, summer workshop time, time to travel to conferences, all kinds of time. Second comes technical support. Just because a faculty member can afford to buy his own personal computer without college or even department funds, doesn't mean he can afford the supporting software and interfaces and technical support and data bases needed to go with that thousand dollar machine. Once the requirements for curriculum are clear, technical support is needed from the academic computing center to search for appropriate software, design appropriate machine configurations and communications networks, help in designing and writing programs, consult on a variety of issues, and provide seminars, workshops and minicourses tailored to the needs of that academic area. The days of the standard Fortran or Basic programming course for everyone are long gone.

5. Organizational arrangements. Implicit in the above is the requirement for organizational arrangements specifically designed for support of academic computing. Not the computer science department. The demands of industry for computer scientists is placing a terrible strain on computer science departments. It's harder to get and keep good faculty at the same time that enrollments are burgeoning. The need of the other academic departments for consulting and support and courses tailored to their students needs, have got to take second place in the priorities of a good computer science department. Similar considerations apply to the administrative computing center.

Because microcomputers are so cheap, you might think there isn't a need for a central support organization for academic computing. Everyone does his own thing. This idea is wrong for many reasons. First, software and courseware are far more costly than hardware, and no cheaper now than ever. Second, expertise is no cheaper than ever. With more and more computers around, and more and more applications to be developed, there is an even greater need for central support functions than ever before. The consensus panel on computing in higher education pointed out the need for greater interdependence within and among colleges. One of the major functions to be performed by this support organization is searching for and acquiring and implementing appropriate software and courseware and data bases that will meet the needs of the faculty, students and curriculum. This is a very time consuming job, especially with the proliferation of microcomputers and related software. It takes a long time to become familiar with the sources, the clearinghouses, the methods for acquiring and evaluating software, so this is one of those functions that can most cost-effectively be provided by someone who specializes in doing this.

When the search for appropriate software or courseware or data bases is unsuccessful in meeting a need, help is needed in developing same. Developing software and courseware is very expensive and can very easily be done badly. A centralized support organization should be available to provide methodological assistance to the content experts. A good model for this is the Educational Technology Center at the University of California, Irvine, where both researchand development assistance is provided to faculty in developing their computer based dialogues, simulations, laboratory exercises, and self-study materials.

We'll have to depend more heavily on students for developing software and providing technical assistance. Two year colleges are handicapped because they don't have the upper division and graduate students to provide this critical resource. Perhaps work-study arrangements can be made to bring these in to the community colleges part time.

6. Help from Industry. The survival of industry is at stake in this computer literacy movement. Industry desperately needs graduates who have the information-handling, problem-solving, and high-technology skills we are addressing here. All possible avenues for collaboration, cooperation, and outright gifts from industry must be explored.

7. Tell pre-college institutions your requirements for entry skills and knowledge on the part of entering students. New demands are being made on your institutions by our changing world. It is only reasonable that high schools and elementary schools take up their share of the burden by providing students with the fundamental information-handling and problem-solving and communications skills they need. Schools are looking for guidance on this point, and there is so far very little available to them in the way of direction from the college community.

VII. The Freshmen of 1985

What level of computer literacy should we expect of the freshmen of 1985? First, I would expect an increasing spread among students on this dimension. Some students are gaining quite in depth experiences with computing in high school, while others are getting no formal exposure at all.

The National Center for Educational Statistics surveyed school districts this past winter with regard to students access to computers. They found 52,000 computers and terminals available to students in the nation's 15,800 school districts. The interesting part is that 30,600 of these are microcomputers, which are very likely to have been acquired in the past two years. So we have a more than doubling of the number of computers available to students in the past couple years.

According to this survey, about 1 of every 4 public schools currently has at least one microcomputer or computer terminal for instructional use by students. These represent one-half of all secondary schools, 14 percent of all elementary schools, and 19 percent of all other types of schools, such as vocational, special education, and others. The most frequently reported educational use of these is to provide students with an understanding of computer concepts, which they call computer literacy. Other major uses are to improve student learning in selected subject areas and to challenge high achievers.

Now, the hardware picture will of course change rapidly. Already we know, for example, that 85% of high school students have access to a hand calculator. Personal computers are quickly moving to the personal price range -- Commodore's VIC computer, costing $299, has far more capability than one of the first machines I worked with in the mid-sixties, and that one cost over a hundred thousand!

So many students will be coming to you with a sense of computer confort, and an increasing number will have experience in programming in BASIC. They'll have a general idea about computer applications in business and industry. But most will be very weak in the areas of structuring their problem solutions, documenting their programs, using information-retrieval systems, and understanding ethical and social issues. They will likely have used some simulations, but won't know much about how to critique them or how to build a model. They will have general familiarity and comfort in using a keyboard and perhaps a primitive text editor, but they won't be schooled in the use of word processors. They will have seen some fancy computer graphics in the form of video games, but they won't have much idea of how to apply these to engineering, science, management and so forth.

I think this increase in disparity among entering students is going to continue for the foreseeable future. Therefore, I think we have no choice but to go in the direction of increasing individualization of our courses. We're going to have to provide lots of learning resources and find ways to let students go at their own pace and in their own directions. For students who are not very well motivated or self-directed, we'll need to provide individualized tutorials and other mechanisms for structuring their learning.

We have now the responsibility and the opportunity to forge new processes and products as we take control of this computer revolution and direct it in ways that will serve the values and purposes that we think are important. Good luck!

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